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April 29, 2005
In reply refer to 2005RC1315

Mr. Rodney H. Nelson
California Regional Water Quality
Control Board – Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, CA 90013

Mr. Ray LeClerc
Department of Toxic Substances Control
8800 Cal Centre Drive
Sacramento, CA 95826-3200

Subject: Happy Valley Interim Measures Biotreatment Progress Report
Santa Susana Field Laboratory, Ventura County, CA
Waste Discharge Requirements (WDR) Order No. R4-2004-0112
File No. 04-022, Monitoring and Reporting Program CI-8722

Dear Mr. Nelson and Mr. LeClerc:

Boeing is pleased to submit the attached letter report from MWH Americas, Inc., to update the Regional Water Quality Control Board (RWQCB) and the Department of Toxic Substances Control (DTSC) on progress with the Happy Valley Interim Measures (HVIM) biotreatment program. The setup of the biotreatment systems at the Building 376, 316, and 359 areas was completed in mid-October 2004, with water application beginning on October 19, 2004 at two of the areas, and on October 24, 2004 at the other area. The initial water and amendment applications were completed at the Building 376 and 316 areas by mid-December 2004. The initial water and amendment applications were about 70 percent complete at the Building 359 area at the time that operations were suspended pending the resumption of warmer, dryer weather on February 14, 2005.

Progress with the actual biodegradation of perchlorate in soil has been slower than anticipated. Reasons for the slower than anticipated rate of biodegradation include: 1) slower infiltration rates of water and amendments into the biotreatment piles than anticipated; 2) cold seasonal temperatures in winter which reduce the rate of microbial activity; and 3) frequent rainfall events that

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necessitated suspension of water and amendment application at one of the areas. Details are provided in the attached letter report.

Please do not hesitate to contact me at (818) 586-5695 with any questions or comments.

Sincerely,

BOEING

Art Lenox
Environmental Remediation

AL:pj

Enclosure

Cc: Steve Baxter, DTSC – Glendale (w/ attachment)
Gerard Abrams, DTSC – Sacramento (w/o attachment)
Dixie Hambrick, MWH (w/o attachment)
Robert Borch, GeoSyntec (w/ attachment)
Evan Cox, GeoSyntec (w/ attachment)

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MWH

April 28, 2005

Mr. Art Lenox
The Boeing Company
Rocketdyne Propulsion and Power
6633 Canoga Avenue
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Canoga Park, CA 91309-7922

Subject: Progress Report for Happy Valley Soil Biotreatment, Happy Valley Interim Measures Project, Santa Susana Field Laboratory

Dear Mr. Lenox:

The purpose of this letter report is to provide a status update for the Happy Valley Soil Biotreatment Program being conducted at the Santa Susana Field Laboratory (SSFL). Soil treatment is one component of the Happy Valley Interim Measures (HVIM) Program, of which the overall goal is to reduce the concentration of perchlorate in soil in the area such that its migration via storm water runoff is mitigated, and surface water quality objectives are satisfied. Soil remediation in Happy Valley is being achieved through a combination of excavation and off-site disposal, and biotreatment of sediment and soil that contains perchlorate. This letter report describes the progress of the biotreatment component of the HVIM.

SCOPE OF BIOTREATMENT PROGRAM

The HVIM biotreatment program is designed to treat approximately 20,000 cubic yards of soil that is present in three locations referred to as the Building 359, Building 316, and Building 376 areas at the SSFL (Figure 1). The soil includes *ex situ* soil and sediment that was excavated from Happy Valley and transported to the Building 359 area as well as the upper three feet of *in situ* soil at the Building 359, Building 316, and Building 376 areas. The program encompasses the biotreatment of both *in situ* and *ex situ* soils (Table 1).

For purposes herein, the initiation of biotreatment is defined as occurring at the time that all of the amendments to the targeted biotreatment soils have been successfully delivered

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throughout the treatment zone. Amendments include water and three environmentally-friendly chemical products that will provide a source of food for naturally occurring microbial organisms present in the soil. By fostering conditions in the soil that are favorable to the growth of the microbial population present in the soil, perchlorate will be consumed along with the amendments, and reduced to harmless chloride ion and water. Chemical products used as biotreatment amendments include calcium magnesium acetate (CMA), which is a road deicing agent, methyl soyate (a soy oil-based biodiesel), and citric acid (a food additive).

Water is a key amendment for the biotreatment of perchlorate. Perchlorate degrades readily under anaerobic conditions, and water serves not only as a critical source of moisture to support the growth of the microbial population, but also as an agent to physically force air, and thus oxygen, out of the soil. The delivery of water throughout the treatment zone is important to the cultivation of anaerobic conditions favorable for the biodegradation of perchlorate.

Delivery of water to the targeted biotreatment soils at the Building 359, 316, and 376 areas is by infiltration from the surface of the biotreatment areas where it is applied via agricultural drip tape. The objective is to deliver sufficient water to the soils to bring its moisture content to near field capacity, the maximum amount of water the soil will hold without draining further to depth. The thickness of the biotreatment zones at the Building 359 (4-15 feet), 316 (5-8 feet), and 376 (3 feet) areas is different, with portions of the Building 359 area being much thicker than that of either the Building 316 or the Building 376 areas. For this reason, delivery of water throughout the biotreatment zone at the Building 359 area requires more time than is required for either the Building 316 or the Building 376 areas.

The time required to deliver water throughout the biotreatment zones at the Building 359, 316, and 376 areas has been greater than estimated in the biotreatment work plan because the average permeability of the soils is characteristically less than that of the soil samples previously tested in the laboratory. At this time, the initial doses of water and amendments have been successfully delivered to the Building 316 and 376 areas. The initial water application is not yet complete at the Building 359 area.

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BIOTREATMENT PREPARATIONS AT THE BUILDING 316, 376, AND 359 AREAS

The success of a biotreatment program targeting the destruction of perchlorate in soil depends largely on the thoroughness of the distribution of amendments throughout the targeted soils. For this reason, the biotreatment program entailed the application of three different chemical products, and thorough mixing of the targeted soils. Details of the biotreatment preparations for the Building 316, 376, and 359 areas are provided below.

The implementation of biotreatment at the Building 316 area involves approximately 1,600 cubic yards of *ex situ* soils, and approximately 400 cubic yards of *in situ* soils. More *ex situ* soils were stockpiled at the Building 316 area than originally planned (1,600 cubic yards as compared to 1,000 cubic yards) to create more room at the Building 359 area to facilitate the staging of soil spreading operations.

The upper one foot of *in situ* soil at the Building 316 area was broken up using a tractor with a ripper attachment. CMA was blended in during the ripping operation to distribute the amendment throughout the surficial soils. Approximately 0.8 pounds of CMA were added per cubic yard of soil to be treated. Potassium bromide was also added to the *in situ* soils at a rate of 0.06 pounds per cubic yard to serve as a conservative tracer and surrogate for the purpose of monitoring potential infiltration of perchlorate to groundwater.

A portion of the *ex situ* soil from Happy Valley that was transported to and stockpiled at the Building 359 area was moved to the Building 316 area and spread in 1-foot-thick lifts, and tilled with agricultural tilling equipment. Methyl soyate was sprayed on the surface of each lift of soil, prior to tilling, at a rate of approximately 0.125 liters per cubic yard of soil. CMA was added to every other lift of *ex situ* soil at the rate of 0.8 pounds per cubic yard to further improve the distribution of amendments throughout the *ex situ* soils. *Ex situ* soils were stockpiled at the Building 316 area to a depth of approximately 5 feet.

The upper 2 feet of *in situ* soils at the Building 376 area were ripped with a tractor, and CMA and potassium bromide were blended in as described above for the Building 316 area. No *ex situ* soil treatment is being performed at the Building 376 area.

As was the case for the Building 316 and 376 areas, the upper one foot of the *in situ* soil layer at the Building 359 area was ripped with a tractor, and CMA and potassium

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bromide were blended into the soil. The Building 359 area biotreatment pile was constructed in 1-foot-thick soil lifts, with each lift of soil ripped and/or tilled with a tractor with a ripper attachment or an agricultural tiller. Given the relatively large size of the Building 359 area, and the natural grade at the site, there is considerable variability in the depth of the soil pile across the site. The northwest corner of the biotreatment pile is approximately 12 feet deep, while the southeast corner of the pile is approximately 1 foot deep.

Following construction of the biotreatment piles at the Building 316, 376, and 359 areas, an agricultural drip tape water distribution system was constructed. Agricultural drip tape with an emitter rate of 0.175 gallons per 100 lineal feet was used. Drip tape was arranged in parallel lines over the entire surface of the biotreatment areas, at a spacing of approximately 3 feet between each line of drip tape. The water source was a nearby hydrant served with water from the Calleguas Municipal Water District. The water from the hydrant was routed through a granular activated carbon filter as a conservative measure to ensure water quality, and then through a system of valves and gauges to allow monitoring and control of the water application rate. A Dosatron® metering pump is used to dose the water to be applied through the drip tape with food-grade citric acid.

Separate agricultural drip tape systems with independent controls were designed and installed for the Building 316 and 376 areas. The Building 359 area, given its relatively large size of approximately two acres, was subdivided into four quadrants of approximately a half-acre each (see Figure 1). Separate agricultural drip tape systems that can be independently controlled by a system of meters and valves were installed for each quadrant. In this manner, the application of water to one quadrant can be discontinued if the field capacity is achieved at the target depth, while water application can continue at other quadrants that may have a thicker soil horizon. This is essential for the Building 359 area given the variability of the soil thickness across the site. In total, there are six agricultural drip tape systems with independent controls that share a common water and amendment source at the site.

During the construction of the biotreatment piles, two potable water pipeline leaks occurred during the biotreatment preparations in separate incidents on September 9 and 10, 2004, when heavy equipment used for tilling and soil movement ruptured water lines in and around the biotreatment area. These incidents were described in a letter to the California Department of Toxic Substances Control (DTSC) dated October 8, 2004. The

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water released from the September 9 incident did not leave the Building 359 site. The water released during the September 10 incident flowed downgradient of the biotreatment areas in a lined surface channel that terminated in a concrete-lined sump that was drained by two culvert pipes. One culvert pipe terminated at the R-1 Pond, and the other culvert pipe terminated in a brushy area upgradient of the R-1 Pond. Inspection following the incident revealed that the R-1 Pond was dry, while the soils in the brushy area upgradient of the R-1 Pond were damp. The water released during the September 10 incident did not leave the SSFL site boundary. Soil/ sediment samples were collected from the lined channel and the damp brushy area upgradient of the R-1 Pond and analyzed for perchlorate (Figures 2 and 3). Perchlorate was not detected in any of the samples (Table 2).

STORMWATER CONTROL MEASURES

Following construction of the water distribution system, the three biotreatment areas were covered with plastic tarps to prevent the biotreatment soils from coming into contact with storm water runoff. These plastic covers are anchored with sandbags to prevent wind damage. Straw waddles surround the biotreatment areas to filter sediment from stormwater runoff. Stormwater runoff is diverted around the biotreatment areas utilizing sandbags and straw bales.

In the event that the agricultural drip tape system fails or leakage from under the tarp occurs because the water application rate is excessive, a water collection and treatment system was installed with approximately 40,000 gallons of storage capacity (i.e., storage capacity to contain a drip tape failure at 25 gallons per minute (gpm) for approximately 24 hours, without treatment). The collection system includes channels constructed of sand bags to route seepage from the biotreatment piles to a collection sump located at the northwest corner of the Building 359 area (see Figure 1). This is a natural low point in the surrounding topography, and seepage from each of the biotreatment areas would drain to this collection point should it occur. The collection sump is lined with plastic, and includes a sump pump to transfer water to nearby storage tanks. A transfer pump from the storage tanks routes waters through bag and string wound filters prior to processing through two ion exchange units arranged in series. Treated water is discharged to a lined channel that flows towards the R-1 Pond (Figure 2).

Plastic tarps effectively prevent storm water from contacting soils that contain perchlorate as evidenced by sampling results (Table 3). Water is not applied to the

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biotreatment piles if wet weather is expected to avoid the possibility that storm water runoff could mix with seepage water from the biotreatment piles that may contain perchlorate.

WATER APPLICATION AND MOISTURE MONITORING

Water application via drip tape began with pilot-tests conducted at the Building 376 and 316 areas on October 19, 2004. A water application pilot-test was conducted at the Building 359 area beginning on October 23, 2004. The purpose of the pilot-tests was to verify that the previously estimated infiltration rates and capacities of the soil were accurate. In conducting the pilot-tests, soil moisture versus depth was monitored on a weekly basis during the initial water application process. Soil samples were collected and analyzed in a laboratory during the first two weeks to calibrate qualitative field observations with quantitative results.

The pilot-testing results indicated that the infiltration rates of the subject soils were slower than that of the soils tested in the laboratory during the bench-scale studies. Evidently, the *ex situ* soils excavated and transported from the Happy Valley drainage were finer-grained than the *in situ* soils collected and tested from the Building 359 area. It was also estimated that in addition to the infiltration rates being significantly slower, that the field capacity of the *ex situ* soils stockpiled at the Building 316 and 359 areas was on the order of 80 percent of that estimated from the bench-scale test results.

In addition to visually inspecting soil moisture infiltration, pressure/ vacuum lysimeters were installed on November 19, 2004 to monitor the presence of vadose-zone fluids in each of the three biotreatment areas (Figure 4). A total of 19 lysimeters were installed (Table 4). Lysimeters are used to monitor the depth of moisture infiltration into the soil horizon at the three biotreatment areas, and for the purpose of collecting soil moisture samples for acetate, nitrate/ nitrite, and total organic carbon content analysis (Table 5). The absence of nitrate/ nitrite in soil moisture provides a cost-effective indication that conditions are conducive to the anaerobic biodegradation of perchlorate.

The initial water application was completed at Building 376 on November 24, 2004, and at Building 316 on December 12, 2004. A total of 14,400 gallons of water were applied at Building 376. Approximately 107,800 gallons of water were applied at Building 316. During the water application process, no moisture was observed to migrate below the targeted treatment depths (approximately three feet below the original surface grade) of

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the Building 316 and 376 biotreatment areas. Percent moisture results ranged from 10 to 18 percent by weight in these areas (Table 6).

The thickness of the biotreatment pile at the Building 359 area presented a greater challenge for water application than that of the Building 316 and 376 areas. In particular, the thickness of the biotreatment zone in Quadrant 1 (as much as 15 feet) required more time for water to infiltrate to depth, resulting in sufficient time for the formation of small channels on the surface of the biotreatment pile. As surface channels formed over time, they became armored with fine-grained silts. The resulting network of surface channels, armored with silts, effectively reduced the infiltration capacity of the Building 359 area over time from an initial 24 gpm in aggregate across all four quadrants to as little as 2.5 gpm in aggregate. This slowed biotreatment progress further as the water application rate had to be continually reduced to prevent runoff from the surface of the soil pile. For this reason, the objective of achieving field capacity throughout the four quadrants of the Building 359 area was not realized prior to the wet weather season.

The reduced infiltration capacity contributed to an overflow event that occurred on Sunday, December 12, 2004, during the water application process at the Building 359 area. During this event, as previously reported to the RWQCB in a letter dated December 21, 2004, water was applied at a rate (6 gpm per quadrant) that the Building 359 biotreatment area had previously absorbed via infiltration, but that was in excess of its current infiltration capacity. The result was runoff from the biotreatment area that collected in the sump at the northwest corner of the Building 359 area, prior to its transfer to nearby storage tankage. Unfortunately, the transfer pump in the storage tank was inoperable pending a retrofit the weekend of December 11-12, and thus water could not be routed from the storage tank to the treatment system. Given that a portion of the storage capacity was already occupied by water, inadequate storage capacity was available to store the excess water that ran-off from the biotreatment area to the collection sump. The result was an overflow event on Sunday, December 12, where water overtopped the storage tank and flowed toward the R-1 Pond. Water from both the storage tank and the R-1 Pond was sampled for chemical analysis following the event. Perchlorate was not detected in the samples collected from the R-1 Pond, and only at a concentration of 9.4 micrograms per liter (μg/L) in the sample collected from the treatment system storage tank (Table 7).

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Operationally, the protocol is not to apply water to the biotreatment piles during rain events or when wet weather is expected. This is a precaution to avoid the possibility of a failure of the agricultural drip tape system during a rain event, resulting in the potential mixture of irrigation water that had contacted soils that contain perchlorate with storm water runoff. Because of this, water was not applied during several weeks between the end of December 2004 and February 2005. The combination of a thick soil biotreatment zone, slow infiltration rates that were decreasing over time, and an unusually wet winter that further constrained the application of water to the Building 359 area, resulted in the decision to postpone further water application until the wet weather season was over. Water application at the Building 359 area was suspended for the season on February 14, 2005, prior to achieving field capacity across the entire biotreatment zone.

Prior to suspension of water application at the Building 359 area, approximately 430,000 gallons of water were applied. Water application was substantially complete at Quadrants 2, 3, and 4, and approximately 70 percent complete at the thickest quadrant, Quadrant 1. Lysimeter sampling indicated that moisture had infiltrated uniformly to the 6-foot depth interval, but had not penetrated to the deepest lysimeters, installed at a depth of approximately 10 feet. It is anticipated that water application will resume at the Building 359 area in the May/ June timeframe, although probably not until the surface of the soil pile is tilled to break up the channels that have formed on the surface of the pile.

SOIL PERCHLORATE SAMPLING RESULTS

Prior to water application, baseline perchlorate sampling was conducted to evaluate the levels of perchlorate in the biotreatment soils. Eleven sample locations were selected randomly, including one at the Building 376 area, two at the Building 316 area, and two at each of four quadrants at the Building 359 area (Figure 4). At each sample location, four discrete random depths were sampled. The four discrete samples were composited into one sample and analyzed for perchlorate (EPA 314.0), total organic carbon (TOC) (EPA SW-846), and nitrate. A few of the samples were analyzed for acetate. Sample results are summarized in Table 6.

The one composite sample collected from the Building 376 area contained a baseline perchlorate concentration of 110 micrograms per kilogram (µg/kg). Baseline perchlorate concentrations in samples collected from the Building 316 area ranged from 79 to 100 µg/kg. At the Building 359 area, baseline perchlorate concentrations ranged from 16 to 480 µg/kg.

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Performance monitoring samples were collected at the Building 376 and 316 areas on January 19 and February 3, 2005. As discussed and agreed with DTSC during a site visit on November 23, 2004, samples were collected across the entire thickness of the soil piles by boring through the entire biotreatment zone with a hand auger. The soil samples were then processed through a splitter until approximately a 250-milliliter soil sample was derived. Perchlorate was extracted from the samples in the laboratory, and the extract was chemically analyzed (Table 6).

The results of the performance monitoring samples collected to date are mixed. Perchlorate was detected in the extracts of samples collected from the Building 376 area at concentrations ranging from 13 to 450 µg/L. It is noted that the *in situ* soils of the Building 376 area are characteristically more heterogeneous than the soils of the other two biotreatment areas.

The performance monitoring results for the Building 316 area are more consistent, with concentrations of perchlorate in laboratory extractions ranging from undetected at 4 µg/L to 65 µg/L. Five of six perchlorate in soil extract results for the Building 316 area are 7.2 µg/L or less.

TEMPERATURE EFFECTS ON BIOTREATMENT RATES

Soil temperature has been documented to have a profound effect on the denitrification of nitrate and nitrite ions in soil, with denitrification rates curtailed at soil temperatures less than 60 degrees Fahrenheit, and essentially stopped at 50 degrees Fahrenheit (Peck 1998). It is reasonable to presume that the same microflora responsible for the denitrification of nitrate and nitrite in soil are responsible for the biodegradation of perchlorate.

Soil temperatures as measured at the nearby Piru - #101 California Irrigation Management Information System (CIMIS) monitoring station that is maintained by the California Department of Water Resources dipped below 60 degrees Fahrenheit (58.3) on average in November 2004. Soil temperatures in the area typically do not climb above 60 degrees until March. Average soil temperatures at the Piru monitoring station as measured in December 2004, and January and February 2005, were 56.0, 53.7, and 55.9 degrees Fahrenheit, respectively. These temperatures are sufficiently low to significantly curtail the biodegradation rate of perchlorate in soil. It is hypothesized that

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low soil temperatures did, in fact, limit biodegradation rates at the Building 376, 316, and 359 areas this past winter.

Soil temperatures measured at the site using a soil temperature probe in the first week of March 2005 revealed temperatures ranging from 56 to 62 degrees Fahrenheit, with an average temperature of 58.9 degrees Fahrenheit. Soil temperatures measured at the site in the second week of March 2005 averaged 60.2 degrees Fahrenheit. Soil temperatures should be above 70 degrees Fahrenheit by the time that moisture application is resumed at the site. It is noted that the average soil temperature at the Piru monitoring station in April 2004 was 70.1 degrees Fahrenheit.

CLOSING

Biotreatment progress has been slower than expected, primarily because of the low permeability of the soils to be treated, the resulting low rate that water infiltrates to depth, and the seasonally low soil temperatures that coincided with the biotreatment amendment applications. Water application was suspended at the Building 359 area on February 14, 2005, although it was frequently disrupted by periods of wet weather prior to this date. Given the unusually wet weather experienced this winter, and the seasonally low soil temperatures, additional water application has been suspended until dryer, warmer weather occurs. Resumption of the biotreatment progress is anticipated in May/June 2005.

If you have questions or comments pertaining to this report or the biotreatment program in general, please contact me at (626) 568-6348 or Bob Aaserude at (925) 975-3543.

Sincerely,
MWH

Dixie Hambrick, R.G.
Project Manager

Robert G. Aaserude, P.E.
Project Engineer

Attachments:

Tables 1-6
Figures 1 - 2

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REFERENCES

Peck, Lindamae. 1998. Remediation of Wastewater by Land Treatment, Consideration of Soil Temperatures in Winter. U.S. Army Corps of Engineers, Cold Regions Research & Engineering Laboratory. CRREL Report 98-8.

www.cimis.water.ca.gov. California Irrigation Management Irrigation System. California Department of Water Resources.

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TABLE 1
SUMMARY OF BIOTREATMENT AMENDMENT APPLICATION INFORMATION
BUILDING 359 BIOTREATMENT CONSTRUCTION AREA
Santa Susana Field Laboratory

Location	Treatment Media	Treatment Area (ft^2)	Treatment Volume (cy)	Amendments[a]	Application Rate	Total Amendment Requirement
Building 316	*in situ* soil	10,925	405	methyl soyate	0.125 liters/cy	14 gallons
				CMA	0.78 pounds/cy	316 pounds
Building 316	*ex situ* soil	10,925	1,610	methyl soyate	0.25 liters/cy	67 gallons
Building 376	*in situ* soil	3,606	400	methyl soyate	0.125 liters/cy	14 gallons
				CMA	0.78 pounds/cy	312 pounds
Building 359[b]	*in situ* soil	81,920	9,100	methyl soyate	0.125 liters/cy	300 gallons
				CMA	0.78 pounds/cy	7,098 pounds
Building 359[b]	*ex situ* soil	81,920	8,490	methyl soyate	0.25 liters/cy	855 gallons

Cy = cubic yard

CMA = Calcium Magnesium Acetate

(a) Citric acid was added as an additional biotreatment amendment in liquid form to the biotreatment pile via agricultural drip tape beginning December 7, 2004 (following approval of the Regional Water Quality Control Board). The application rate of citric acid has been at 0.175 gpm per 100 lineal feet of drip tape (300 parts per million). Because water application ceased at the Building 376 area on November 24, 2004, citric acid was not applied to that area during this reporting period.

(b) Biotreatment amendment application is ongoing at Building 359 area.

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TABLE 2
Soil/Sediment Perchlorate Results
September 10, 2004 Potable Water Release
Santa Susana Field Laboratory

EPA ID	Sample ID	Matrix	Collection Date	Depth (feet bgs)	Concentration	Units
WG001	R1SS01S01	Soil	09/10/2004	0.05	0.043 U	mg/kg
WG002	R1LE01S01	Leachate	09/10/2004	0.05	4.0 U	µg/L
WG003	BSSS04S01	Soil	09/10/2004	0.05	0.051 U	mg/kg
WG004	BSLE04S01	Leachate	09/10/2004	0.05	4.0 U	µg/L

Qualifier Flag:
U = Not Detected

Units:
mg/kg - Milligrams per Kilogram
µg/L - Micrograms per Liter
bgs = below ground surface

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TABLE 3
Surface Water Sample Perchlorate Results
Downgradient of Biotreatment Area
Santa Susana Field Laboratory

EPA ID	Sample ID	Collection Date	Concentration (µg/L)
MP654	BSSW21S01	10/18/2004	3.6 J
MP716	R1SW02S01	12/28/2004	4.0 U
MP721	R1SW02S01	1/3/2005	4.0 U

Notes:
BSSW21S01 - Collected from biotreatment surface water collection sump.
R1SW02S01 - Collected from R-1 Pond after rainfall events caused surface water to flow from Building 359 area to R-1 Pond.

Qualifier Flags:
U = Non-detect
J = Estimated Value (below reporting limit.)

Units:
µg/L = micrograms per liter

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TABLE 4
HVIM Biotreatment Lysimeter Design
Santa Susana Field Laboratory

Site Location	Lysimeter Designation	Lysimeter Depth (feet bgs)
B376	BSBL01	1.5
B316 Quad 1	BSBL02	1.5
B316 Quad 1	BSBL02	6.0
B316 Quad 2	BSBL03	1.5
B316 Quad 2	BSBL03	6.0
B359 Quad 4	BSBL04	1.5
B359 Quad 4	BSBL04	6.0
B359 Quad 4	BSBL05	1.5
B359 Quad 1	BSBL06	1.5
B359 Quad 1	BSBL06	6.0
B359 Quad 1	BSBL06	10.3
B359 Quad 1	BSBL07	1.5
B359 Quad 1	BSBL07	6.0
B359 Quad 2	BSBL08	1.5
B359 Quad 2	BSBL09	1.5
B359 Quad 2	BSBL09	6.0
B359 Quad 3	BSBL10	1.5
B359 Quad 3	BSBL10	6.0
B359 Quad 3	BSBL11	1.5

Notes:
1.) Lysimeter depth represents the bottom depth. The porous cup on the bottom of the lysimeter is 3-inches in length.
2.) Lysimeter locations shown on Figure 4.

bgs = below ground surface

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TABLE 5
HVIM Biotreatment
Lysimeter and Colocated Soil Results
Santa Susana Field Laboratory

Site Location	Location ID	Sample ID	Depth (feet bgs)	Acetate (mg/L)[1]								
				12/03/04	12/10/04	12/14/04	12/17/04	12/22/04	01/05/05	01/13/05	01/14/05	02/10/05
B376	BSBL01	BSWL01S01	1.5	**0.4 J**	**0.5 J**		1 U	**1.8 ***	0.5 U*			
B316 Quad 1	BSBL02	BSWL02S01	1.5			0.09 U	1 U	0.5 U*				
B316 Quad 1	BSBL02	BSBL02S01	1.5									
B316 Quad 1	BSBL02	BSWL02S02	6			0.09 U	1 U	0.5 U*	0.5 U*			
B316 Quad 1	BSBL02	BSBL02S02	6									
B316 Quad 2	BSBL03	BSWL03S01	1.5			**0.8 J**	0.5 U					
B316 Quad 2	BSBL03	BSWL03S02	6			0.5 U		**1.6 ***	0.5 U*			
B359 Quad 4	BSBL04	BSWL04S01	1.5				1 U	0.5 U*	0.5 U*			0.5 U*
B359 Quad 4	BSBL04	BSBL04S01	1.5									
B359 Quad 4	BSBL04	BSWL04S02	6				1 U	0.5 U*	0.5 U*			
B359 Quad 4	BSBL04	BSBL04S02	6									
B359 Quad 4	BSBL05	BSWL05S01	1.5				1 U	**2.8 ***	0.5 U*			
B359 Quad 1	BSBL06	BSWL06S01	1.5									
B359 Quad 1	BSBL06	BSBL06S01	1.5									
B359 Quad 1	BSBL06	BSWL06S02	6				0.5 U	0.5 U*	0.5 U*			
B359 Quad 1	BSBL06	BSBL06S02	6									
B359 Quad 1	BSBL06	BSWL06S03	10.3					0.5 U*			0.5 U*	
B359 Quad 1	BSBL06	BSBL06S03	10.3							1 U*		
B359 Quad 1	BSBL07	BSWL07S01	1.5					0.5 U*	0.5 U*			
B359 Quad 1	BSBL07	BSWL07S02	6				0.5 U	0.5 U*	0.5 U*			
B359 Quad 2	BSBL08	BSWL08S01	1.5				2	**2.8 ***	0.5 U*			
B359 Quad 2	BSBL09	BSWL09S01	1.5				0.5 U	**1.7 ***	0.5 U*			
B359 Quad 2	BSBL09	BSBL09S01	1.5									
B359 Quad 2	BSBL09	BSWL09S02	6				0.5 U	0.5 U*	0.5 U*			
B359 Quad 2	BSBL09	BSBL09D02	6									
B359 Quad 2	BSBL09	BSBL09S02	6									
B359 Quad 3	BSBL10	BSWL10S01	1.5				1 U	0.5 U*	0.5 U*			
B359 Quad 3	BSBL10	BSBL10S01	1.5									
B359 Quad 3	BSBL10	BSWL10S02	6				1 U	0.5 U*	0.5 U*		0.5 U*	0.5 U*
B359 Quad 3	BSBL10	BSBL10S02	6							1 U*		
B359 Quad 3	BSBL11	BSWL11S01	1.5				1 U	0.5 U*	0.5 U*			

HDMSe00163166

TABLE 5
HVIM Biotreatment
Lysimeter and Colocated Soil Results
Santa Susana Field Laboratory

Site Location	Location ID	Sample ID	Depth (feet bgs)	Nitrate-N (mg/L)[1]								
				12/10/04	12/14/04	12/17/04	12/22/04	01/05/05	01/12/05	01/13/05	01/27/05	02/10/05
B376	BSBL01	BSWL01S01	1.5	450		420	360 *	370 *	370 *		160 *	51 *
B316 Quad 1	BSBL02	BSWL02S01	1.5		31	30	28 *		27 *			24 *
B316 Quad 1	BSBL02	BSBL02S01	1.5							1.2 U*		
B316 Quad 1	BSBL02	BSWL02S02	6		22	20	15 *	16 *			9.6 *	2.9 *
B316 Quad 1	BSBL02	BSBL02S02	6							1.3 U*		
B316 Quad 2	BSBL03	BSWL03S01	1.5		30	0.55 U						18 *
B316 Quad 2	BSBL03	BSWL03S02	6		2.9		1.1 U*	0.27 *	0.55 U*		0.55 U*	0.55 U*
B359 Quad 4	BSBL04	BSWL04S01	1.5			0.11 U	0.11 U*	0.11 U*	0.11 U*		0.22 U*	0.22 U*
B359 Quad 4	BSBL04	BSBL04S01	1.5							1.3 U*		
B359 Quad 4	BSBL04	BSWL04S02	6			2.6	1 *	0.61 *	0.26 *		0.26 *	0.22 U*
B359 Quad 4	BSBL04	BSBL04S02	6							1.2 U*		
B359 Quad 4	BSBL05	BSWL05S01	1.5			0.12	0.11 U*	0.11 U*	0.11 U*		0.11 U*	0.11 U*
B359 Quad 1	BSBL06	BSWL06S01	1.5									0.22 U*
B359 Quad 1	BSBL06	BSBL06S01	1.5							1.2 U*		
B359 Quad 1	BSBL06	BSWL06S02	6			11	3.3 *	1.2 *	0.43 *		0.22 U*	0.22 U*
B359 Quad 1	BSBL06	BSBL06S02	6							5.9 *		
B359 Quad 1	BSBL06	BSWL06S03	10.3				47 *		74 *		94 *	130 *
B359 Quad 1	BSBL06	BSBL06S03	10.3							5.9 *		
B359 Quad 1	BSBL07	BSWL07S01	1.5				6.3 *	6.3 *	5.9 *		6 *	4.7 *
B359 Quad 1	BSBL07	BSWL07S02	6			26	9.4 *	2.2 *	0.24 *		0.22 U*	0.22 U*
B359 Quad 2	BSBL08	BSWL08S01	1.5			1.4	0.23 *	0.22 U*	0.76 *		0.41 *	0.55 U*
B359 Quad 2	BSBL09	BSWL09S01	1.5			20	15 *	15 *	8.2 *		7.5 *	7.7 *
B359 Quad 2	BSBL09	BSBL09S01	1.5							1.2 U*		
B359 Quad 2	BSBL09	BSWL09S02	6			39	72 *	89 *	77 *		64 *	52 *
B359 Quad 2	BSBL09	BSBL09D02	6							11 *		
B359 Quad 2	BSBL09	BSBL09S02	6							9 *		
B359 Quad 3	BSBL10	BSWL10S01	1.5			0.08	0.11 *	0.11 U*	0.11 U*		0.11 U*	0.22 U*
B359 Quad 3	BSBL10	BSBL10S01	1.5							1.3 U*		
B359 Quad 3	BSBL10	BSWL10S02	6			17	18 *	18 *	19 *		16 *	17 *
B359 Quad 3	BSBL10	BSBL10S02	6							3.1 *		
B359 Quad 3	BSBL11	BSWL11S01	1.5			8.8	7.2 *	7.8 *	7.2 *		5.4 *	4.3 *

HDMSe00163167

TABLE 5
HVIM Biotreatment
Lysimeter and Colocated Soil Results
Santa Susana Field Laboratory

Site Location	Location ID	Sample ID	Depth (feet bgs)	Nitrite-N (mg/L)[1]								
				12/10/04	12/14/04	12/17/04	12/22/04	01/05/05	01/12/05	01/13/05	01/27/05	02/10/05
B376	BSBL01	BSWL01S01	1.5	1.5 U		0.3 U	**1.7 ***	0.75 U*	0.75 U*		0.3 U*	0.15 U*
B316 Quad 1	BSBL02	BSWL02S01	1.5		**0.66**	0.3 U	**1.7 ***		0.3 U*			0.75 U*
B316 Quad 1	BSBL02	BSBL02S01	1.5							1.7 U*		
B316 Quad 1	BSBL02	BSWL02S02	6		0.75 U	0.3 U	0.75 U*	0.75 U*			0.75 U*	0.75 U*
B316 Quad 1	BSBL02	BSBL02S02	6							1.7 U*		
B316 Quad 2	BSBL03	BSWL03S01	1.5		**0.53**	0.75 U						0.3 U*
B316 Quad 2	BSBL03	BSWL03S02	6		0.75 U		1.5 U*	0.3 U*	0.75 U*		0.75 U*	0.75 U*
B359 Quad 4	BSBL04	BSWL04S01	1.5			0.15 U	0.15 U*	0.75 U*	0.15 U*		0.3 U*	0.3 U*
B359 Quad 4	BSBL04	BSBL04S01	1.5							1.8 U*		
B359 Quad 4	BSBL04	BSWL04S02	6			0.75 U	1.5 U*	0.75 U*	0.3 U*		0.3 U*	0.3 U*
B359 Quad 4	BSBL04	BSBL04S02	6							1.7 U*		
B359 Quad 4	BSBL05	BSWL05S01	1.5			0.15 U	0.15 U*	0.3 U*	0.15 U*		0.15 U*	0.15 U*
B359 Quad 1	BSBL06	BSWL06S01	1.5									0.3 U*
B359 Quad 1	BSBL06	BSBL06S01	1.5							1.7 U*		
B359 Quad 1	BSBL06	BSWL06S02	6			0.75 U	1.5 U*	1.5 U*	0.3 U*		0.3 U*	0.3 U*
B359 Quad 1	BSBL06	BSBL06S02	6							1.7 U*		
B359 Quad 1	BSBL06	BSWL06S03	10.3				1.5 U*		3 U*		1.5 U*	1.5 U*
B359 Quad 1	BSBL06	BSBL06S03	10.3							1.7 U*		
B359 Quad 1	BSBL07	BSWL07S01	1.5				0.3 U*	0.3 U*	0.3 U*		0.57 *	0.3 U*
B359 Quad 1	BSBL07	BSWL07S02	6			0.75 U	**0.89 ***	0.75 U*	0.3 U*		0.3 U*	0.3 U*
B359 Quad 2	BSBL08	BSWL08S01	1.5			0.3 U	0.15 U*	0.3 U*	0.75 U*		0.3 U*	0.75 U*
B359 Quad 2	BSBL09	BSWL09S01	1.5			0.3 U	0.3 U*	0.3 U*	0.75 U*		0.3 U*	0.3 U*
B359 Quad 2	BSBL09	BSBL09S01	1.5							1.7 U*		
B359 Quad 2	BSBL09	BSWL09S02	6			0.75 U	0.3 U*	0.75 U*	3 U*		0.75 U*	0.75 U*
B359 Quad 2	BSBL09	BSBL09D02	6							1.7 U*		
B359 Quad 2	BSBL09	BSBL09S02	6							1.7 U*		
B359 Quad 3	BSBL10	BSWL10S01	1.5			0.15 U	0.15 U*	0.15 U*	0.15 U*		0.15 U*	0.3 U*
B359 Quad 3	BSBL10	BSBL10S01	1.5							1.7 U*		
B359 Quad 3	BSBL10	BSWL10S02	6			0.3 U	0.75 U*	0.75 U*	0.75 U*		0.3 U*	0.75 U*
B359 Quad 3	BSBL10	BSBL10S02	6							1.7 U*		
B359 Quad 3	BSBL11	BSWL11S01	1.5			0.15 U	**0.75 ***	0.3 U*	0.3 U*		0.15 U*	0.3 U*

HDMSe00163168

TABLE 5
HVIM Biotreatment
Lysimeter and Colocated Soil Results
Santa Susana Field Laboratory

Site Location	Location ID	Sample ID	Depth (feet bgs)	Total Organic Carbon (mg/L)[1]			
				01/13/05	01/14/05	01/27/05	02/10/05
B376	BSBL01	BSWL01S01	1.5		**36 ***	**33 ***	**17 ***
B316 Quad 1	BSBL02	BSWL02S01	1.5				**37 ***
B316 Quad 1	BSBL02	BSBL02S01	1.5	5600 U*			
B316 Quad 1	BSBL02	BSWL02S02	6		**40 ***	**41 ***	**39 ***
B316 Quad 1	BSBL02	BSBL02S02	6	5700 U*			
B316 Quad 2	BSBL03	BSWL03S01	1.5				**12 ***
B316 Quad 2	BSBL03	BSWL03S02	6		**53 ***	**68 ***	**49 ***
B359 Quad 4	BSBL04	BSWL04S01	1.5		**50 ***	**52 ***	**60 ***
B359 Quad 4	BSBL04	BSBL04S01	1.5	5900 U*			
B359 Quad 4	BSBL04	BSWL04S02	6		**44 ***	**53 ***	**39 ***
B359 Quad 4	BSBL04	BSBL04S02	6	5600 U*			
B359 Quad 4	BSBL05	BSWL05S01	1.5		**35 ***	**32 ***	**35 ***
B359 Quad 1	BSBL06	BSWL06S01	1.5		**12 ***		**46 ***
B359 Quad 1	BSBL06	BSBL06S01	1.5	5600 U*			
B359 Quad 1	BSBL06	BSWL06S02	6		**20 ***	**24 ***	**22 ***
B359 Quad 1	BSBL06	BSBL06S02	6	5800 U*			
B359 Quad 1	BSBL06	BSWL06S03	10.3		**13 ***	**13 ***	**15 ***
B359 Quad 1	BSBL06	BSBL06S03	10.3	5500 U*			
B359 Quad 1	BSBL07	BSWL07S01	1.5		**13 ***	**14 ***	**11 ***
B359 Quad 1	BSBL07	BSWL07S02	6		**35 ***	**34 ***	**39 ***
B359 Quad 2	BSBL08	BSWL08S01	1.5		**40 ***	**84 ***	**38 ***
B359 Quad 2	BSBL09	BSWL09S01	1.5		**18 ***	**19 ***	**22 ***
B359 Quad 2	BSBL09	BSBL09S01	1.5	5700 U*			
B359 Quad 2	BSBL09	BSWL09S02	6		**9.4 ***	**8.3 ***	**8.3 ***
B359 Quad 2	BSBL09	BSBL09D02	6	5500 U*			
B359 Quad 2	BSBL09	BSBL09S02	6	5500 U*			
B359 Quad 3	BSBL10	BSWL10S01	1.5		**85 ***	**86 ***	**89 ***
B359 Quad 3	BSBL10	BSBL10S01	1.5	5800 U*			
B359 Quad 3	BSBL10	BSWL10S02	6		**4.8 ***	**4.6 ***	**3.2 ***
B359 Quad 3	BSBL10	BSBL10S02	6	5600 U*			
B359 Quad 3	BSBL11	BSWL11S01	1.5		**4.3 ***	**5.1 ***	**4.6 ***

Notes:

1.) Soil matrix sample results are reported in milligrams per kilogram (mg/kg).

Highlighted rows represent colocated soil samples (prefix BSBL) that correspond to the Lysimeter pore water samples (prefix BSWL) with the same location ID.

Bold indicates detected results.

bgs = below ground surface

Qualifier Flags:
U = Not Detected
J = Estimated value
* = Data not validated (in-progress engineering performance data).

HDMSe00163169

TABLE 6
Happy Valley Biotreatment
Baseline and Performance Evaluation Samples
Santa Susana Field Laboratory
1 of 2

Site Location	Location ID	Sample ID	Acetate (mg/kg)	Nitrate-N (mg/kg)				Nitrite-N (mg/kg)		Moisture (%[2])		Perchlorate (units[1])				Total Organic Carbon (mg/kg)			
			02/03/05	10/04/04	10/05/04	01/19/05	02/03/05	01/19/05	02/03/05	11/16/04	11/22/04	10/04/04	10/05/04	01/19/05	02/03/05	10/04/04	10/05/04	01/19/05	02/03/05
B376	BSBR01	BSBR01S01		5.4		1.2 *		1.7 U*				110				7400		9300 *	
B376	BSBR01	BSLR01S01												130 *					
B376	BSBR24	BSBR24S01								10 *									
B376	BSBR25	BSBR25S01								11 *									
B376	BSBR26	BSBR26S01								13 *									
B376	BSBR26	BSBR26S02								11 *									
B376	BSBR27	BSBR27S01								18 *									
B376	BSBR28	BSBR28S01								12 *									
B376	BSBR28	BSBR28S02								13 *									
B376	BSBR29	BSBR29S01	1.0 *				4.7 *		1.7 U*										5700 U*
B376	BSBR29	BSLR29S01													450 *				
B376	BSBR30	BSBR30S01					1.3 U*		1.7 U*										5700 U*
B376	BSBR30	BSLR30S01													13 *				
B316 Quad 1	BSBR03	BSBR03S01		0.83 J		1.2 U*		1.7 U*				100				5300 U		5700 U*	
B316 Quad 1	BSBR03	BSLR03S01												65 *					
B316 Quad 1	BSBR31	BSBR31S01	0.8 *				1.3 U*		1.7 U*										5800 U*
B316 Quad 1	BSBR31	BSLR31S01													1.1 J*				
B316 Quad 1	BSBR32	BSBR32S01					1.3 U*		1.7 U*										5700 U*
B316 Quad 1	BSBR32	BSLR32S01													7.2 *				
B316 Quad 1	HVBR05	HVBR05S01									13 *								
B316 Quad 1	HVBR05	HVBR05S02									13 *								
B316 Quad 1	HVBR06	HVBR06S01									15 *								
B316 Quad 1	HVBR06	HVBR06S02									14 *								
B316 Quad 1	HVBR07	HVBR07S01									14 *								
B316 Quad 1	HVBR07	HVBR07S02									15 *								
B316 Quad 1	HVBR08	HVBR08S01									15 *								
B316 Quad 1	HVBR08	HVBR08S02									15 *								
B316 Quad 2	BSBR02	BSBR02S01		2.5		1.2 U*		1.7 U*				79				5400 UJ		5600 U*	
B316 Quad 2	BSBR02	BSLR02S01												2.5 J*					
B316 Quad 2	BSBR33	BSBR33S01					1.3 *		1.7 U*										5600 U*
B316 Quad 2	BSBR33	BSLR33S01													4 U*				
B316 Quad 2	BSBR34	BSBR34S01					1.2 U*		1.7 U*										5700 U*
B316 Quad 2	BSBR34	BSLR34S01													4 U*				
B316 Quad 2	HVBR01	HVBR01S01									13 *								
B316 Quad 2	HVBR01	HVBR01S02									16 *								
B316 Quad 2	HVBR02	HVBR02S01									13 *								
B316 Quad 2	HVBR02	HVBR02S02									14 *								
B316 Quad 2	HVBR03	HVBR03S01									12 *								
B316 Quad 2	HVBR03	HVBR03S02									13 *								
B316 Quad 2	HVBR04	HVBR04S01									13 *								
B316 Quad 2	HVBR04	HVBR04S02									13 *								

HDMSe00163170

TABLE 6
Happy Valley Biotreatment
Baseline and Performance Evaluation Samples
Santa Susana Field Laboratory
2 of 2

Site Location	Location ID	Sample ID	Acetate (mg/kg)	Nitrate-N (mg/kg)				Nitrite-N (mg/kg)		Moisture (%[2])		Perchlorate (units[1])				Total Organic Carbon (mg/kg)			
			02/03/05	10/04/04	10/05/04	01/19/05	02/03/05	01/19/05	02/03/05	11/16/04	11/22/04	10/04/04	10/05/04	01/19/05	02/03/05	10/04/04	10/05/04	01/19/05	02/03/05
B359 Quad 1	BSBR06	BSBR06S01		**1.2**								**130**				5500 U			
B359 Quad 1	BSBR08	BSBR08S01		**3.3**								**270**				5400 U			
B359 Quad 1	BSBR09	BSBR09S01		**0.38 J**								46 U				5800 U			
B359 Quad 1	BSBR17	BSBR17S01			**1.6**								**16 J**				5400 U		
B359 Quad 1	BSBR18	BSBR18S01			**2.9**								**82**				5500 U		
B359 Quad 2	BSBR07	BSBR07S01		**4.4**								**79**				5400 U			
B359 Quad 2	BSBR13	BSBR13S01			**14**								**16 J**				**2000 J**		
B359 Quad 2	BSBR14	BSBR14S01			**1.1 J**								45 U				**5200 J**		
B359 Quad 2	BSBR15	BSBR15S01			1.2 U								45 U				**2400 J**		
B359 Quad 2	BSBR16	BSBR16S01			1.4 U								50 U				**5800 J**		
B359 Quad 3	BSBR04	BSBR04S01		**3.9**								**100**				5500 U			
B359 Quad 3	BSBR11	BSBR11S01		1.2 U								**25 J**				5400 U			
B359 Quad 3	BSBR12	BSBR12S01			**5.7**								**98**				5400 U		
B359 Quad 3	BSBR22	BSBR22S01			1.3 U								47 U				5800 U		
B359 Quad 3	BSBR23	BSBR23S01			**16**								**99**				5400 U		
B359 Quad 4	BSBR05	BSBR05D01		**1.4**								**81**				5400 U			
B359 Quad 4	BSBR05	BSBR05S01		**1.7**								**74**				5400 U			
B359 Quad 4	BSBR10	BSBR10S01		**0.49 J**								42 U				5200 U			
B359 Quad 4	BSBR19	BSBR19S01			**0.86 J**								**480**				5400 U		
B359 Quad 4	BSBR20	BSBR20S01			**0.59 J**								45 U				5600 U		
B359 Quad 4	BSBR21	BSBR21S01			**3.3**								**29 J**				5400 U		

Notes:

1.) Perchlorate (units[1]) - Soil matrix results (BSBR) are reported in micrograms per kilogram (µg/kg). Soil Extract samples (BSLR) are reported in micrograms per liter (µg/L).
Soil Extract samples are similar to the Soil Leachate sampes except that the laboratory performs the extraction process (Soil Leachate samples are prepared in the field).

2.) Moisture (%[2]) - These data represent analytical percent moisture results. In addition to these measurements, moisture contenets were visually inspected weekly during the initial water application process and monthly there after.
Water aplication suspended February 2005.

Baseline samples collected in October 2004. Performance Evaluation Samples collected in January and February of 2005.

Bold indicates detected results.

mg/kg = miligrams per kilogram

Qualifier Flags:

U = Not Detcted

J = Estimated value

* = Data not validated (in-progress engineering performance data).

HDMSe00163171

TABLE 7
Water Sample Analytical Results
December 12, 2004 Water Overflow Event
Santa Susana Field Laboratory

EPA ID	Sample ID	Collection Date	Analyte	Concentration	Units
MP675	BSSW22S01	12/13/2004	Dissolved Oxygen	5.1	mg/L
		12/13/2004	Perchlorate	9.4 J	µg/L
		12/13/2004	Total Suspended Solids	42	mg/L
		12/13/2004	Turbidity	160	NTU
		12/13/2004	pH	6.99	pH Units
MP676	R1SW02S01	12/13/2004	Dissolved Oxygen	7.1	mg/L
		12/13/2004	Perchlorate	4.0 U	µg/L
		12/13/2004	Total Suspended Solids	10 U	mg/L
		12/13/2004	Turbidity	4.4	NTU
		12/13/2004	pH	8.66	pH Units

Qualifier Flags:
U = Not Detected
J = Estimated value

Units:
mg/L - Milligrams per Liter
µg/L - Micrograms per Liter
NTU - Nephelometric Turbidity Units

HDMSe00163172

Figure 1
Approximate Limits of
In Situ/Ex Situ Biotreatment Activities
at Bldg 359 Biotreatment Area

MWH

Feb. 2005

Area I Road

Collection Sump

Bldg 359 Area

Treatment System and
Water Storage Tanks

Approximate Limits of
In Situ/Ex Situ
Biotreatment Activities

Bldg 376 Area

Research Road

Approximate Limits of
In Situ/Ex Situ
Biotreatment Activities

Bldg 316 Area

1900
1925
1950
1975

Legend

399 Building Number

25-Foot Topographic Contour

Construction Area

Approximate Limits of In Situ/Ex Situ Biotreatment Activities (Feb. 2005)

Note:
Areas Where Tar Plants Occur Have Been Excluded from Biotreatment.

0 FEET 75
SCALE

JOB No. -- FILE No. INDSVR\INDUSTRIAL\CAD MLUEBKE\BOEING\SANTA SUSANA\NPDES PERMIT 10 2003\bldg 359 BTA 2 2 05

HDMSe00163173

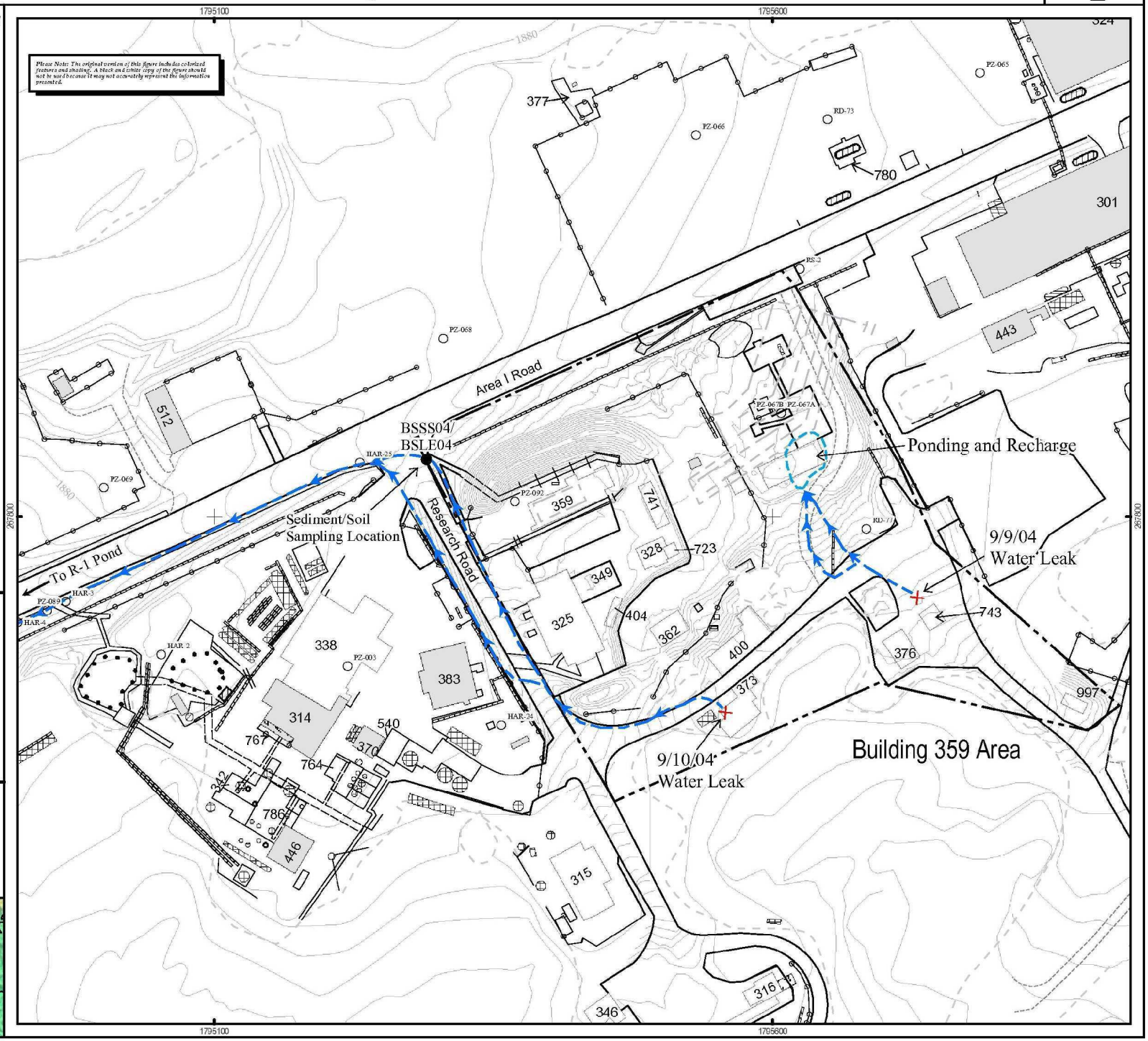
Boeing / Santa Susana Field Laboratory

FIGURE 2

SANTA SUSANA FIELD LABORATORY
BUILDING 359 AREA

Legend

- Water Flow
- Ponding and Recharge
- Sediment/Soil Sampling Location



Base Map Legend

- Existing Building or Structure
- Removed Building or Structure
- Other Tanks, R Indicates Removed
- Solvent Tanks, R Indicates Removed
- Petroleum Fuel/Oil Tanks, R Indicates Removed
- Hydrazine (MMH, UDMH, HZ) Tanks, R Indicates Removed
- Awnings
- Administrative Area Boundary
- RFI Site Boundary
- Ground Elevation Contours
- A/C Curbing
- Dirt Road
- Ponds
- Possible Ponds (approx. location)
- Fences
- Pipes
- Drainage Pathways
- Rock Outcrops
- Leach Field
- Monitoring Wells

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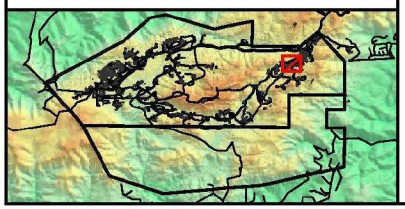
0 120
FEET



HDMSe00163174

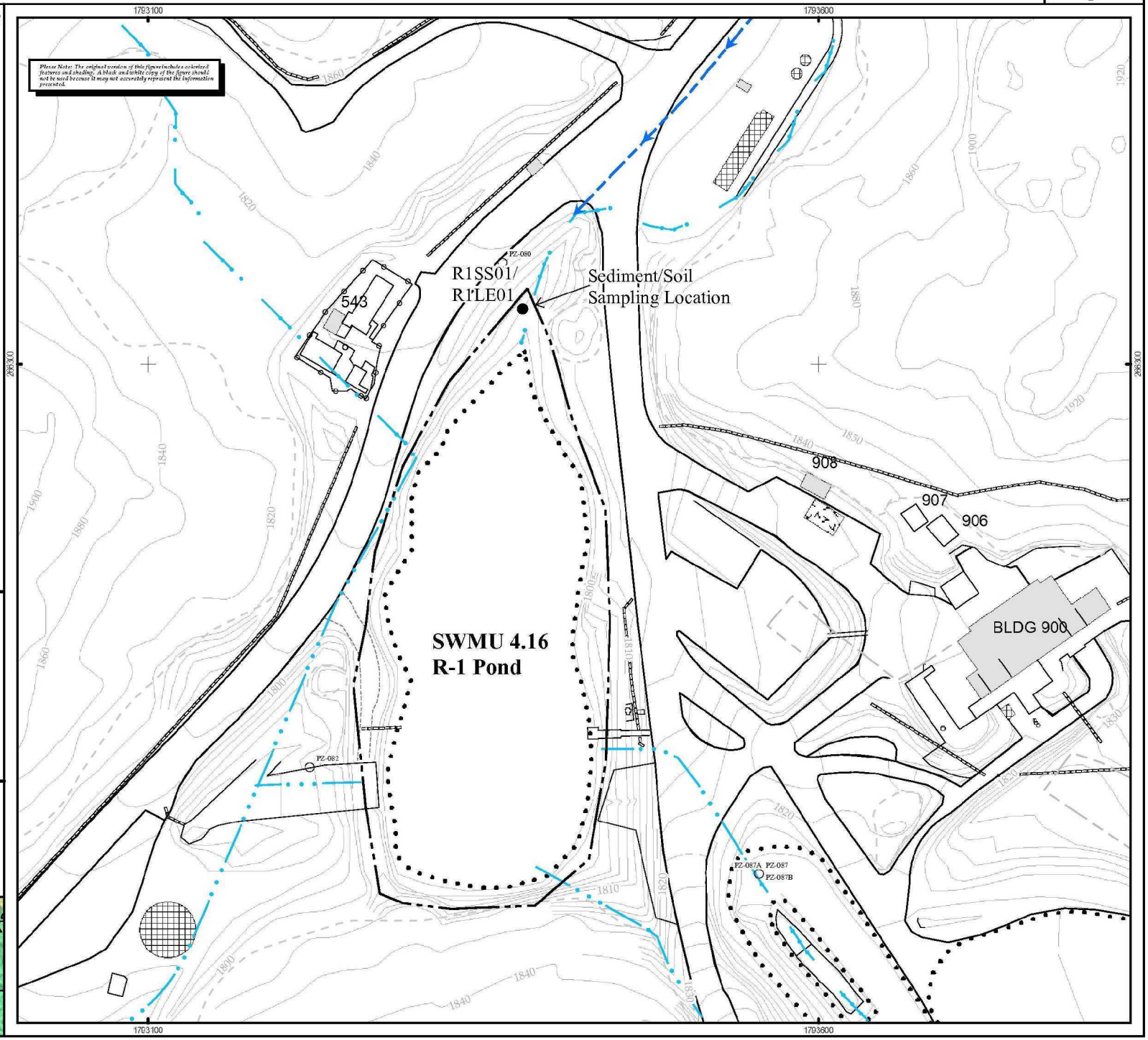
Boeing / Santa Susana Field Laboratory

FIGURE 3

SANTA SUSANA FIELD LABORATORY
R-1 POND

Legend

- Water Flow
- Sediment/Soil Sampling Location



Base Map Legend

- Existing Building or Structure
- Removed Building or Structure
- Other Tanks, R Indicates Removed
- Solvent Tanks, R Indicates Removed
- Petroleum Fuel/Oil Tanks, R Indicates Removed
- Hydrazine (MMH, UDMH, HZ) Tanks, R Indicates Removed
- Awnings
- Administrative Area Boundary
- RFI Site Boundary
- Ground Elevation Contours
- A/C Curbing
- Dirt Road
- Ponds
- Possible Ponds (approx. location)
- Fences
- Pipes
- Drainage Pathways
- Rock Outcrops
- Leach Field
- Monitoring Wells

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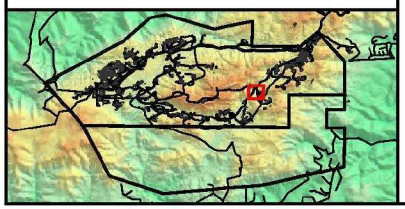
0 80
FEET



HDMSe00163175

Please Note: The original version of this figure includes colorized features and shading. A black and white copy of the figure should not be used because it may not accurately represent the information presented.

Storm Water Culvert

Area I Road

Research Road

BSBR14
BSBR15
BSBR16
BSBR17
BSBR07
BSBR18
BSBL08
BSBR13
BSBL07
BSBL09
BSBR09
BSBL06
BSBR06
BSBR08
BSBR12
BSBL11
BSBR04
BSBL10
BSBR05
BSBR22
BSBR23
BSBL04
BSBR19
BSBL05
BSBR11
BSBR20
BSBR21
BSBR10

Building 359 Area

Building 376 Area

BSBR26
BSBR27
BSBR01
BSBR29
BSBL01
BSBR28
BSBR25
BSBR30
BSBR24

Building 316 Area

HVBR07
HVBR08
HVBR01
BSBR02
BSBL03
BSBR33
BSBR31
HVBR02
BSBR03
HVBR06
HVBR05
BSBR32
HVBR04
BSBL02
BSBR34
HVBR03

HVIM Bio-Treatment Sampling Locations

Santa Susana Field Laboratory

Legend

- Baseline Sampling Locations
- Performance Sampling Locations
- Lysimeter Locations
- Moisture Monitoring Locations
- Approximate Limits of In Situ/Ex Situ Biotreatment Activities (Feb. 2005)

MAP COORDINATES IN STATEPLANE, NAD 27, ZONE V

0 40 FEET

FIGURE 4

Date: Apr 28, 2005
File: r:\rock\plots\arcmap\ssfl_building_359_area_ben_cc.mxd

MWH

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